Case Study No. 10 High-Solids Coatings
Ethan Allen
Beecher Falls, VT

Background

Ethan Allen's Beecher Falls facility manufactures several styles of high-quality bedroom and non-upholstered living room furniture. The plant has approximately 500 employees and is the main economic force in the Beecher Falls area. The facility is located in the northeastern-most point in Vermont, on the border with both New Hampshire and Canada.

This facility was one of the largest emitters of air pollutants in the State. Every year their reports under SARA Title III publicized their position as one of the State's "worst polluters." In an effort to improve their image within Vermont and to comply with both Vermont's air toxics rule and the Wood Furniture NESHAP, the Beecher Falls plant decided to make changes that would reduce their air emissions. This case study describes the conversion to high-solids sealers and topcoats and other pollution prevention efforts.

Manufacturing and Coating Operations

Previously, the Beecher Falls facility used traditional nitrocellulose-based sealer and lacquer that contained 18 percent and 20 percent solids, respectively. With the traditional coatings, one sealer and two lacquer applications were necessary to meet the company's quality standards. The coatings were applied using conventional spray guns. In an effort to reduce VOC emissions in the early 1990s, Beecher Falls switched to a higher-solids sealer and lacquer that contained approximately 24 percent and 28 percent solids, respectively. They encountered no problems upon switching to these higher solids coatings. Beecher Falls continued to investigate high-solids coatings in an effort to use an even higher-solids product to further reduce air emissions.

After careful evaluation, including pilot testing at the plant, they chose a 35 percent solids sealer and lacquer. The new system was fully operational by March 1995 and is currently in use. Because of the higher solids content of the new lacquer, the need for a second lacquer application was eliminated.

In the late 1980s, the Beecher Falls facility began using HVLP guns for some of their coating applications. The main motivation for this switch was the ergonomics of the lighter guns. However, in 1993 a study was done at the facility to investigate replacing all of the conventional guns with HVLP. On-line testing indicated an increased average transfer efficiency from 30 to 60 percent. This improved coverage reduced the amount of coating lost to overspray as well as the emissions from that overspray. The HVLP guns were implemented quickly.

Conversion to High-Solids Coatings

Through instituting a pollution prevention program, the Beecher Falls Division of Ethan Allen reduced VOC and HAP emissions by 28 and 55 percent, respectively, improved the work environment for its employees, and improved the efficiency of its production process. None of the changes made by Beecher Falls required a substantial capital investment, and each had a short payback period, making the changes economically attractive.

Beecher Falls was able to increase coating solids by working with their coating supplier and their equipment supplier to develop a satisfactory system. For example, the high-solids material could not be applied at room temperature with the HVLP spray guns. There were two feasible alternatives to make the HVLP guns work: using high pressure guns (1,500 to 3,000 psi) or heating the coating material to lower its viscosity. Beecher Falls chose to electrically heat the material in the coating supply line so that it reaches the gun at approximately 90°F. In addition, they modified the HVLP gun cap, nozzle, and tip to enable proper coating application. These modifications have not increased the pressure at the point of atomization beyond the 10 psi definition for HVLP.

The primary benefit to Beecher Falls has been that only one lacquer application is now needed to achieve adequate build. This eliminated the use of the second lacquer spray booth, and the two spray operators were transferred to other positions. At Beecher Falls, this newly available space was particularly valuable, and allowed for changes in the layout of the finishing department to make it more efficient. The elimination of one spray booth also reduced maintenance requirements, and subsequently the amount of solvent cleaner needed. The elimination of the second lacquer coat eliminated the need to sand the surface between coats (scuff sanding), again eliminating the need for two employees to perform this operation.

Reducing the lacquer application to one coat also produced savings on coating material, as well as reducing labor and air emissions. However, eliminating the second lacquer application requires stricter quality control and operator care when the single topcoat is applied. There is no longer a margin for error with the first coat that can be made up for with the second coat. Initially, repair requirements increased. The facility was able to overcome this problem with operator retraining and technique adjustments.

Beecher Falls believes that the new coatings and spray guns have improved worker health and safety conditions at their plant. There is less bounceback when the coatings are applied, reducing potential worker exposure. Lower bounceback also lowers overspray and reduces material use and air emissions further. After an initial period of adjustment, sealer and lacquer operators have expressed satisfaction with the new coatings and appreciate their improved work environment.

The sealer coat now has a better build, so when it is sanded there are less “cut throughs” (the operators do not sand completely through the sealer). This reduces the amount of touch-up required before lacquer application by approximately 30 percent

over the previous sealer. The new lacquer covers defects better and reduces lacquer runs and sag, subsequently decreasing the need for final product repairs by approximately 50 percent. By switching to the high-solids sealer and lacquer, Beecher Falls believes that their final product quality has a fuller feel and better build. However, because the sealer coat has a higher build, it is more difficult to sand and requires an average of 30 percent more time per item. To maintain the same production level, two additional workers have been added to the sanding station. In addition, Beecher Falls replaced their block sanders with orbital sanders and now uses a different grit paper.

Other start-up problems the facility experienced with the new coatings were overcome. For instance, the high-solids sealer requires more time to dry, so Beecher Falls increased the airflow in the sealer flashoff area. The longer drying time and increased airflow increased the potential for dirt to contaminate the coating as it dried. Beecher Falls constructed a flashoff tunnel to help prevent the contamination. Layout changes to the finishing area were required to construct the tunnel.

Other Pollution Prevention and Recycling Efforts

HVLP guns

In the late 1980s, Beecher Falls began using HVLP guns for some of their coating applications because they are lighter and therefore ergonomically preferable when compared to conventional spray guns. Early in 1993, plant personnel investigated the possible benefits of replacing all of the remaining conventional spray guns with HVLP guns. Thorough testing on the actual finishing line for basecoat and stain application revealed (1) an average increase in transfer efficiency from 30 percent with conventional guns to 60 percent with HVLP guns, (2) a 39 percent reduction in the amount of finishing material used to coat the same item, and (3) a corresponding decrease in air emissions from the stations that had been using conventional spray guns.

At the time of the test, Beecher Falls still had 25 conventional spray guns. Approximately 53,000 gallons of finishing material were being sprayed from these 25 guns each year. A 39 percent reduction in material use translated into a savings of over 20,000 gallons of finishing material each year. Beecher Falls estimated that over $145,000 in finishing material purchase costs would be avoided each year if HVLP spray guns were used throughout the plant. The cost of each new HVLP spray gun was approximately $325, or a one-time $8,125 capital cost to produce a savings of over $145,000 each year thereafter. The payback period was less than 3 weeks. The conversion to HVLP spray guns was immediately approved and implemented. The only additional cost was training the operators on how to properly use the new spray equipment.

Waterborne basecoat

Beecher Falls has reformulated their color primer to a waterborne material. However, the waterborne material meets the facility's quality specifications only for opaque enamel applications. The black enamel used over the aqueous primer is still nitrocellulose-based due to space constraints that cannot support the increased drying

time that would be required if aqueous paint were used. Only certain portions of some pieces are painted black, so the overall air emissions from the facility are not significantly affected by the switch to a waterborne primer because it is not used in large quantities.

Waterborne spray booth coating

The spray-on strippable spray booth coating used at Beecher Falls now is waterborne. With 23 spray booths in use, and stain booths coated every 6 weeks and the others coated 4 times each year on average, this coating change also helps to reduce air emissions.

Lacquer dust reclamation

The sealer and topcoat spray booths use metal filters. The filters are brushed at the end of each day to remove as much lacquer dust as possible. The lacquer dust is collected along with dust that has accumulated on the floor and placed in a 55-gallon drum. The dust is hand sifted through filters to remove impurities and then mixed with solvent to make a topcoat material that is used to coat the interior of drawers and backs of items. Beecher Falls uses approximately three 55-gallon drums of reclaimed lacquer dust each week, diverting it from disposal. Approximately one drum of unusable dust (the filter reject) requires disposal as a hazardous waste every month. Including the avoided cost of disposal and the 3 to 4 hours of labor spent on the reclamation effort each day, Beecher Falls estimates that it costs them approximately $4 per gallon to reclaim their lacquer dust; much less than the cost of purchasing new sealer or lacquer. The main drawback to the lacquer dust reclamation effort is that the recovered dust is potentially explosive. Extra care must be taken when handing and storing this material.

Costs

The costs of the conversion to high-solids sealer and lacquer are given below. The internal rate of return was 316 percent and the payback period was 4 months (based on a 5-year analysis, no depreciation of equipment).

Item	Savings or (Cost)
Labor	$175,000 per year
Materials	($42,000) per year
Capital Costs	($42,000)
Internal Rate of Return	316 percent
Net Present Value	$462,176
Payback Period	4 months

Labor

Elimination of two lacquer operators and two scuff sanders, reductions in pre- and post-lacquer touch up, and the addition of two sealer sanders combine for an estimated annual labor savings of approximately $175,000.

Material

The new high-solids coatings are twice as expensive as the original low-solids coatings on a per-gallon basis. However, because the solids content is higher, less material is needed to achieve the same dry mil thickness. In addition, one lacquer application was eliminated. Therefore, the total quantity of coating used is less. Beecher Falls estimated an increased material cost of approximately $42,000 per year. Beecher Falls has not determined the effect on electricity costs resulting from the in-line heaters and the increased airflow in the sealer flashoff area. However, due to the elimination of the second lacquer spray booth and its ventilation requirements, they do not believe there is a substantial increase.

Capital Costs

The cost of adding the in-line electrical heating systems and the flashoff tunnel was approximately $42,000.

Emissions

Air emissions of HAPs and VOCs from the Beecher Falls plant are almost exclusively from the finishing process. Prior to their pollution prevention efforts, the production of furniture involved the application of 70 different finishing materials in a total of nine separate applications. These were all low-solids, solvent-borne coatings. All finishing material is applied manually using a spray gun. In 1992, the plant reported total VOC emissions of 300 tons and HAP emissions of 95.6 tons to the U.S. Environmental Protection Agency.

The VOC and HAP emission reductions have been substantial because air emissions are directly related to the amount of coating used. Eliminating one lacquer application reduced material usage for lacquer coating by 46 percent. If the new coating formulations had the same VOC and HAP content as the old coatings, VOC and HAP emissions from the lacquer application step would be reduced by 46 percent. However, the coating formulations are not the same (42 percent fewer VOCs and 83 percent fewer HAPs), so reportable emissions from the lacquer application step have been reduced by more than 46 percent.

In 1995, production at Beecher Falls was 18.5 percent higher than in 1992, yet total VOC emissions were 257 tons per year and HAP emissions were 50.5 tons per year. Taking increased production into account, VOC and HAP reductions on a per part basis were 28 and 55 percent, respectively. No portion of the emission reduction was achieved through reformulating any coatings with acetone. Some stains and basecoats have been reformulated with acetone as the primary solvent; however, Ethan Allen has included acetone emissions in the 257 tons per year VOC figure. Acetone was removed from the U.S. EPA's VOC list on June 16, 1995 and is not a listed HAP, but it remains as a listed hazardous air contaminant under Vermont regulations.

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